Client:

ARCADIS Italia S.r.l.

Survey site:

Viale Longarone, Zibido San Giacomo (MI)

Geophysical survey for the measurement of soil electrical resistivity and soil thermal resistivity

Report n:	23-421
Written by:	Dott. Tobia Bigini, Ing. Fabrizio Fantini
Checked da:	Dott. Geol. Mario Naldi
Date:	December 2023
Revision:	0

Table of contents

1. INTRODUCTION 1
2. SURVEY LOCATION 2
3. INSTRUMENTS AND PROCESSING SOFTWARE 3
4. SURVEY RESULTS 5
4.1. ELECTRICAL RESISTIVITY MEASUREMENT 5
4.2. THERMAL RESISTIVITY MEASUREMENT 6

Attached:

Drawing 1	Survey location on aerial photo (from *Google Earth Pro*)
Drawings 2÷5	VES profiles and ERT sections
Drawings 6÷9	Thermal resistivity of the soil

Appendix A	Measurement of electrical resistivity on an average soil sample (laboratory test)
Appendix B	Technical specifications

1. INTRODUCTION

This report illustrates and describes the geophysical investigations performed on 18-19-20 December 2023, on behalf of ARCADIS Italia S.r.l., within an area located in Viale Longarone, in the municipal territory of Zibido San Giacomo (Figure 1). The investigations are aimed at the evaluation of the subsoil electrical and thermal resistivity. For this purpose, in agreement with the client, the investigation plan included:

1. N° 4 multi-electrode Electrical resistivity Tomography sections (ERT), from which as many vertical electrical soundings (VES) were extracted.
2. N° 4 measurements of soil thermal resistivity (PIT);
3. Nº 1 laboratory electrical resistivity measurement on an average soil sample.

The location of these tests is shown in Figure 1 and in Drawing 1 (in attachment).

The results of the investigations are shown in the attached drawings and commented in the following pages.

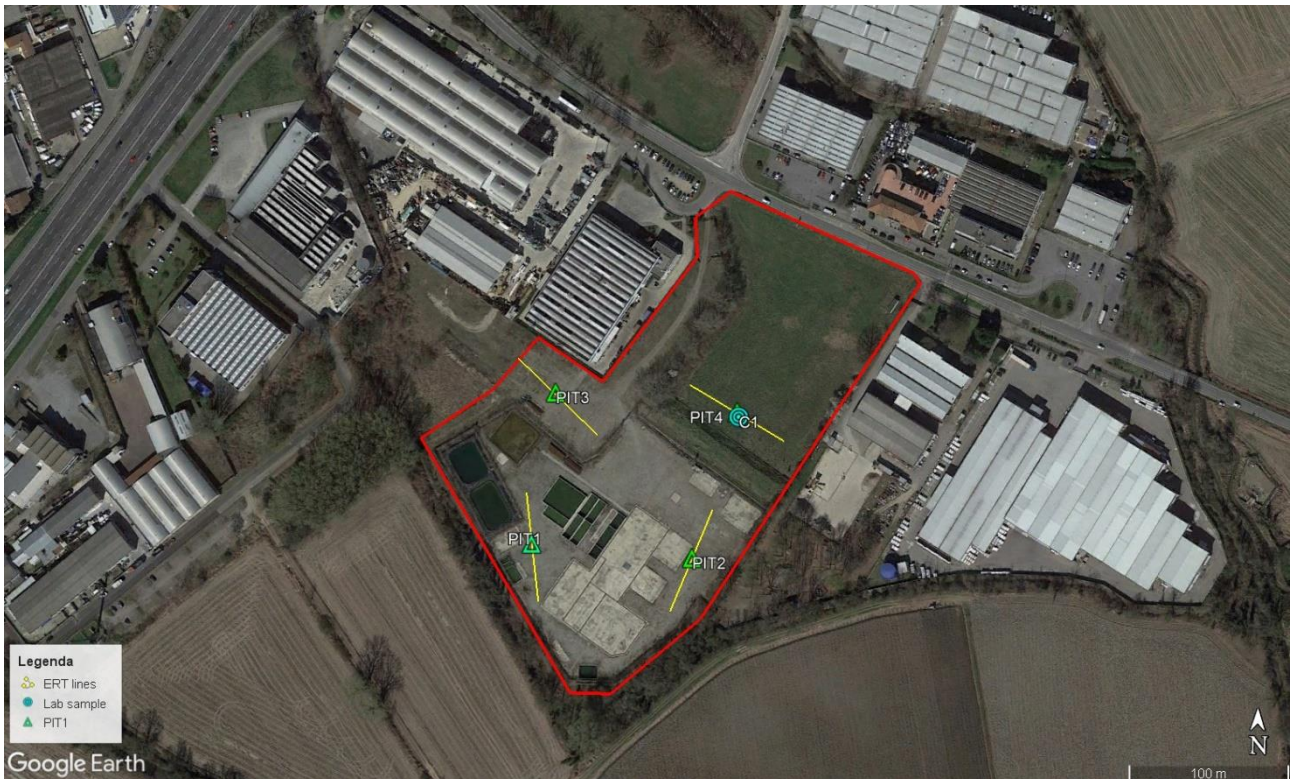

Figure 1 – Location of the in-situ investigations

2. SURVEY LOCATION

The geophysical surveys (VES and PIT) were positioned with a GPS topographic survey (Leica GS14) with RTK type correction, which guarantees an accuracy ± 2 [cm] (https://www.spingnss.it/spiderweb/frmIndex.aspx).

The location of the geoelectric sections (ERTs) was defined on site in relation to site conditions and because of an adequate characterization of the entire area under investigation. The sections involved the placement of 24 electrodes with 3 m spacing (length of each spread equal to 69 m). Thermal resistivity tests were performed approximately in the center of each geoelectric layout. The soil sample for laboratory electrical resistivity measurement was taken near ERT4 section.

The coordinates of the start and end points of the geoelectric spreads, thermal test points, and soil sample collection are given in Table 1 and Drawing 1 in the UTM WGS84 reference system (32N zone).

Table 1 – UTM WGS84 (zone 32N) coordinates of the survey points

Test	Reference Point	East [m]	North [m]
ERT 1	A (0 m)	509808.45	5023414.02
	B (69 m)	509818.16	5023345.70
ERT 2	C (0 m)	509901.29	5023341.94
	D (69 m)	509926.09	5023406.29
ERT 3	E (0 m)	509800.28	5023497.95
	F (69 m)	509852.01	5023452.28
ERT 4	G (0 m)	509909.79	5023483.93
	H (69 m)	509970.21	5023450.55
PIT 1	P1	509813.31	5023381.31
PIT 2	P2	509914.31	5023375.42
PIT 3	P3	509825.20	5023476.08
PIT 4	P4	509938.85	5023467.81
Soil sample	C1	509938.85	5023467.81

3. INSTRUMENTS AND PROCESSING SOFTWARE

The acquisition of geoelectrical data was carried out with a 72-channel Syscal Pro georesistivimeter (Iris Instruments, Fr, photograph in Figure 2) and the use of No. 24 stainless steel electrodes connected by multipole cables. A mixed Wenner-Schlumberger sequence, prepared using Electre Pro software (Iris Instruments, Fr), was adopted for the acquisition of electrical resistivity data.

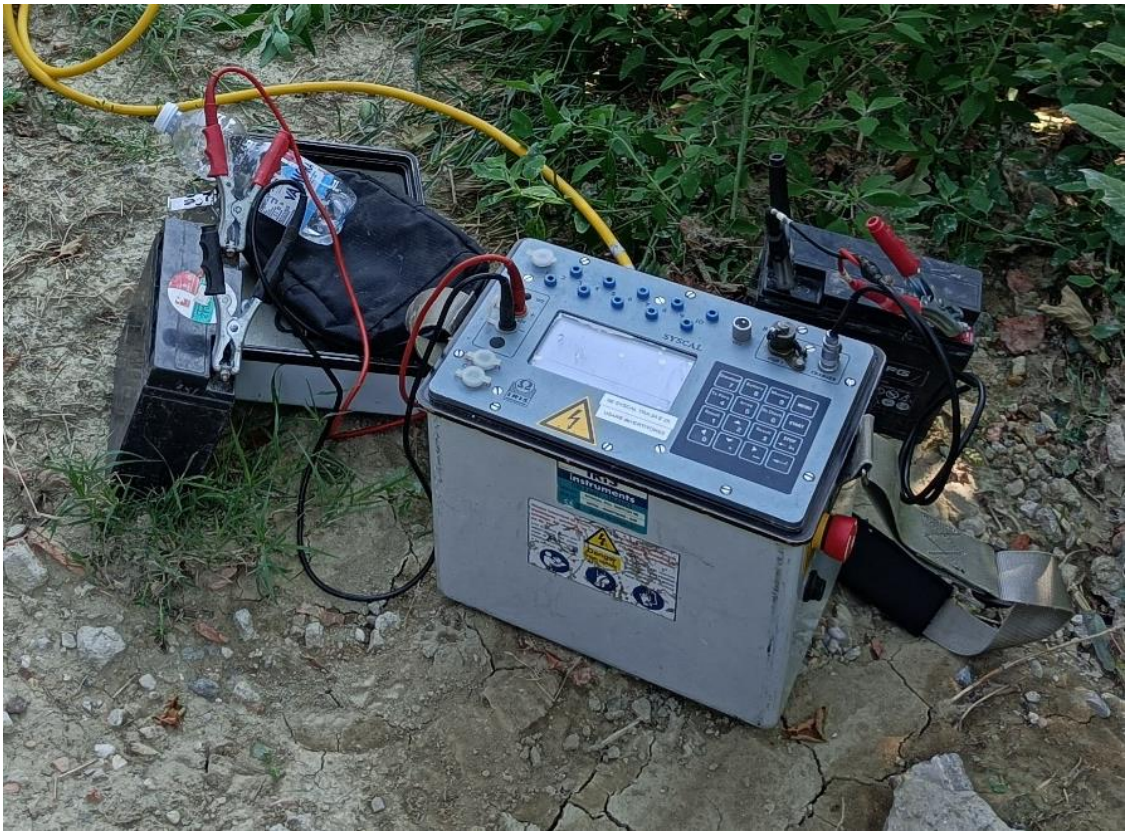

Figure 2 - Georesistivimeter Syscal Pro

The following programs were used for geoelectrical data processing:

- → Prosys III (Iris Instruments, Fr): allows preliminary processing of apparent electrical resistivity data (filtering and topographic correction of data);
- → Res2DINV V.3.71 (Geotomo Software, Mal): performs numerical inversion of the data and restitution of the tomographic section of real electrical resistivity;
- → Surfer 13.6.618 (Golden Software, USA): performs data gridding (kriging method) and graphical representation of tomographic sections.

The on-field measurements of thermal resistivity were made using the instrumentation MAE model A5000T, designed exclusively for thermal resistivity measurements of soils; the measurement was carried out using a probe tip (model CTS-120) connected to the receiver (photograph in Figure 3).

For each survey point (PIT 1÷4), two holes were drilled in the ground, about 1 m deep, to insert the probe. N. 2 thermal resistivity tests were performed in each hole: in such a manner N. 4 tests were performed for each survey point.

Figure 3 – Receiver A500T with needle probe CTS-120

The measurement method is based on the nonstationary sensor technique, using a probe (also known as “thermal needle”), which integrates both a heating wire and a temperature sensor. The probe is inserted into the soil, and by analyzing its response to a heating cycle lasting several minutes, thermal resistivity (or its inverse, conductivity) can be calculated. The measurement principle relies on a distinctive characteristic of a straight-line heat source (the heating wire of the probe): after a brief stabilization period, the temperature rise depends solely on the heating power and the thermal conductivity of the soil. For the thermal resistivity measurement, a 300-second data acquisition period was conducted with a heater voltage of 4 V.

4. SURVEY RESULTS

4.1. ELECTRICAL RESISTIVITY MEASUREMENT

The tomographic models of 2D electrical resistivity (ERT sections) and the corresponding vertical profiles of electrical resistivity (VES) are shown in the attached Drawings 2÷5. The electrical resistivity profiles are shown in both graphical and tabular form (also presented in the following Tables); electrical resistivity values are presented in logarithmic (base 10) and linear scales.

Table 2: VES soundings

VES 1		
Depth [m]	**Rho [log (Ω·m)]**	**Rho [Ω·m]**
0	3.08	1194.0
-1	3.17	1481.3
-2	3.56	3625.3
-3	3.91	8219.1
-4	4.21	16304.9
-5	4.26	18373.9
-6	4.23	16900.8
-7	4.24	17452.8
-8	4.21	16240.4
-9	3.90	7913.6
-10	3.59	3885.8
-11	3.41	2561.8
-12	3.33	2140.6
-13	3.28	1904.8

VES 2		
Depth [m]	**Rho [log (Ω·m)]**	**Rho [Ω·m]**
0	2.82	667.7
-1	2.93	855.0
-2	3.40	2519.1
-3	4.03	10828.8
-4	4.68	47733.2
-5	4.80	63271.0
-6	4.76	57807.7
-7	4.83	68107.2
-8	4.76	57702.7
-9	4.17	14727.3
-10	3.48	3027.1
-11	2.97	924.8
-12	2.60	394.2
-13	2.29	196.2

VES 3		
Depth [m]	**Rho [log (Ω·m)]**	**Rho [Ω·m]**
0	2.04	108.4
-1	2.04	108.7
-2	2.04	110.9
-3	2.06	115.3
-4	2.08	121.3
-5	2.09	123.0
-6	2.09	123.6
-7	2.10	126.0
-8	2.10	124.7
-9	2.06	114.2
-10	2.00	98.9
-11	1.86	72.9
-12	1.69	49.2
-13	1.53	34.2

VES 4		
Depth [m]	**Rho [log (Ω·m)]**	**Rho [Ω·m]**
0	2.60	401.5
-1	2.57	372.2
-2	2.43	266.9
-3	2.25	176.6
-4	2.07	117.2
-5	2.05	111.6
-6	2.06	114.8
-7	2.06	114.1
-8	2.06	114.4
-9	2.04	108.9
-10	2.01	102.1
-11	1.97	93.2
-12	1.92	83.8
-13	1.88	75.6

The results are not homogeneous and are distinguishable into two categories:

→ VES1 and VES2 show really high-resistivity values; the presence of a HDPE sheet (*or similar)* hinders the flow of current, electrically insulating the ground;

→ VES3 presents medium-low values of resistivity (Rho = 100÷125 Ω·m) for the first ten meters of depth, values that gradually decrease in the deeper levels (Rho = 30÷50 Ω·m);

→ VES4 is analogue to VES3 from 4 m b.g.l. down to 13m b.g.l. (Rho = 100÷120 Ω·m) but presents a medium-high resistivity layer (Rho = 200÷400 Ω·m), about 2-3 meters thick, that represents the surface agricultural soil.

The laboratory test performed on the disturbed medium sample (see certificate in Appendix A) gives a resistivity of 69.44 Ω·m, which is significantly lower than that from the in situ tests: this discrepancy is due to the different measurement conditions in terms of the degree of confinement (density), saturation and homogeneity.

4.2. THERMAL RESISTIVITY MEASUREMENT

The numerical data acquired at each individual measuring station (4 measurements divided in 2 holes for each station) were processed using CT-LAB software. All the measurements show a good qualitative trend in the ΔT (°C) - time (s) curve, and the processed data are shown in the attached Drawings 6÷9, in which the measured data and the calculated thermal resistivity and conductivity values are given for each individual survey point. The summary of the results is presented in Table 3, indicating minimum, maximum and average values for each measurement point.

Table 3 - PIT results

Test	Thermal conductivity [W/mK]			Thermal resistivity [mK/W]		
	min	MAX	Average	min	MAX	Average
PIT 1	**1.33**	**2.42**	**1.88**	**0.41**	**0.75**	**0.57**
PIT 2	**2.60**	**3.29**	**2.78**	**0.30**	**0.39**	**0.36**
PIT 3	**0.97**	**1.83**	**1.41**	**0.55**	**1.04**	**0.77**
PIT 4	**1.19**	**1.20**	**1.19**	**0.84**	**0.84**	**0.84**

The Italian standard rule for the design/sizing of the underground electric cables (CEI 20-21) considers a range of variation of the average specific resistivity of the soil between 0.7 °C m/W (very wet soil) and 3.0 °C m/W (very dry soil).

In our case, PIT tests 3 and 4 show homogeneous soils in terms of thermal resistivity and are characterized by low values of thermal resistivity (high conductivity). Test PIT 1 and 2 shows slightly

anomalously low thermal resistivity values (low conductivity), that is probably due to the presence of the HDPE sheet and the higher-than-usual content of water in the ground above the impermeable sheet.

Techgea S.r.l.

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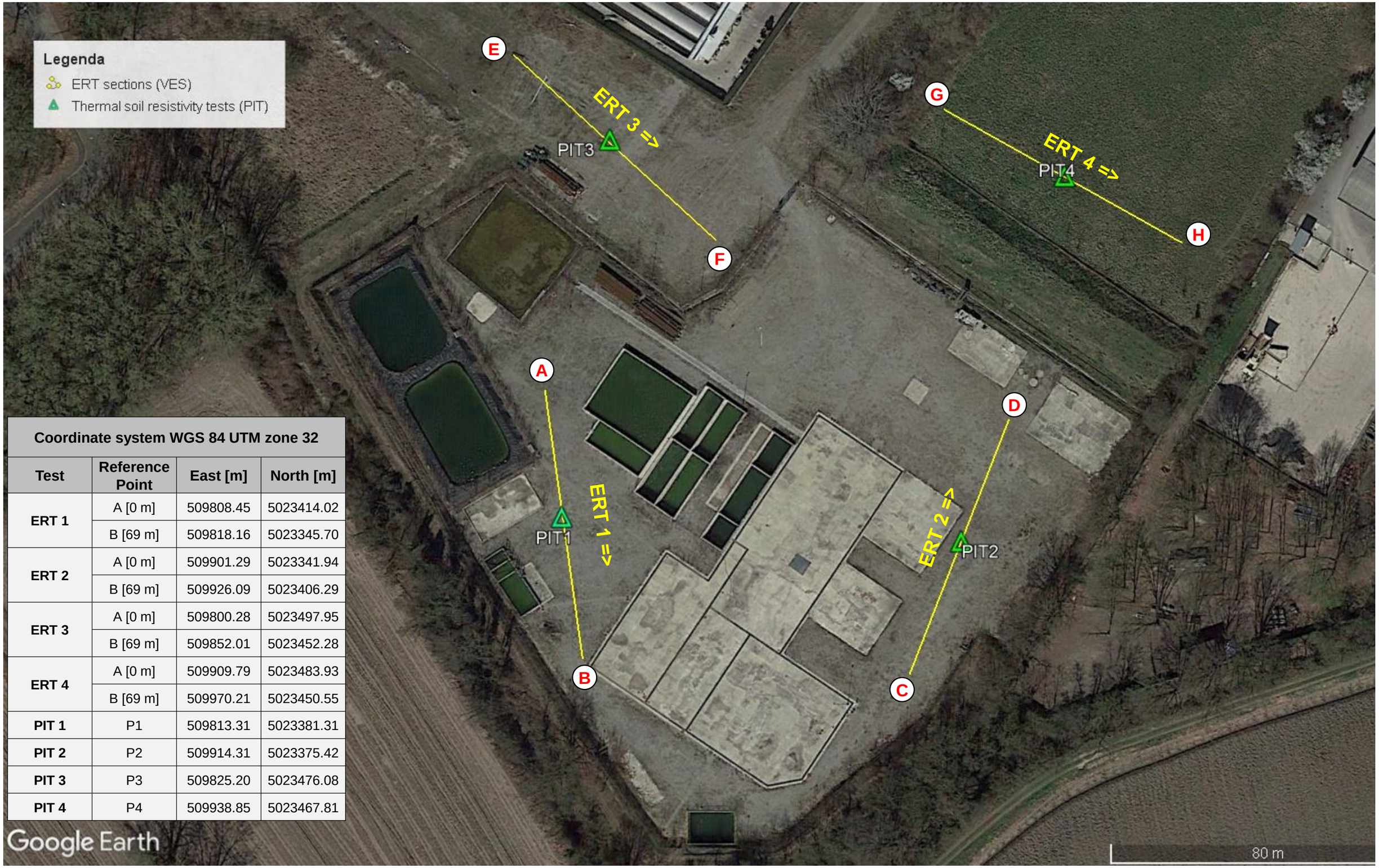
Drawings

Techgea GEOPHYSICS	*Electrical and thermal soil resistivity tests* ***Survey location (from Google Earth Pro)***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 1



Coordinate system WGS 84 UTM zone 32			
Test	**Reference Point**	**East [m]**	**North [m]**
ERT 1	A [0 m]	509808.45	5023414.02
	B [69 m]	509818.16	5023345.70
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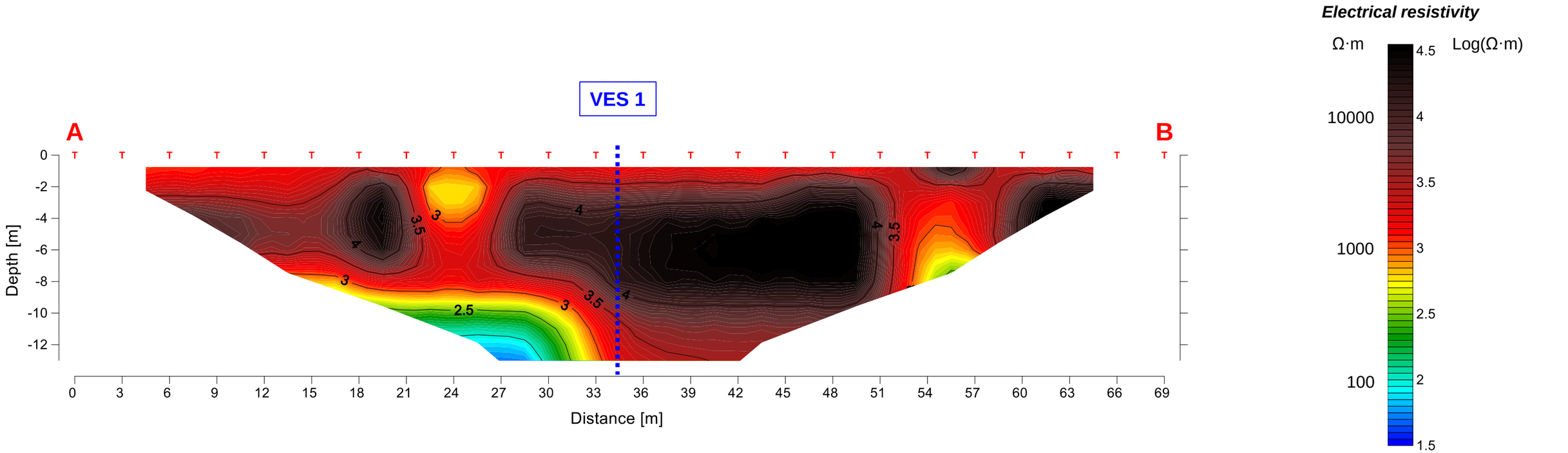
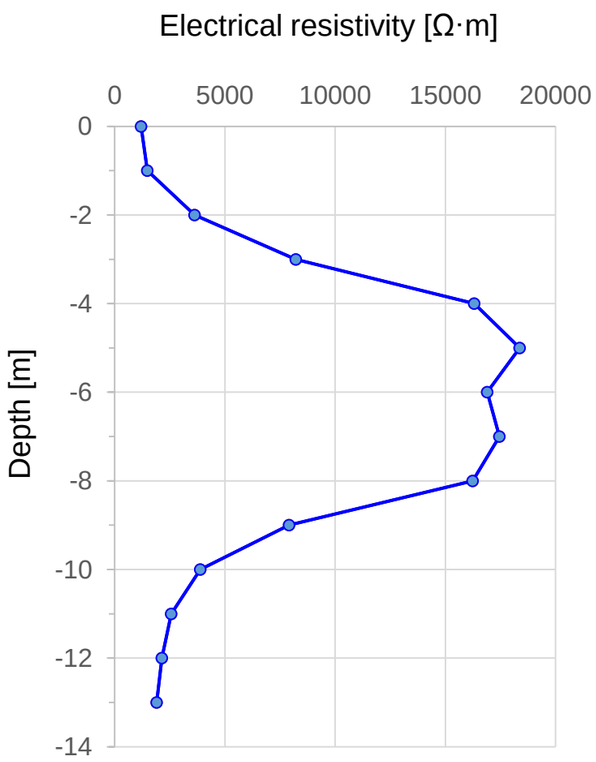
	B [69 m]	509852.01	5023452.28
ERT 4	A [0 m]	509909.79	5023483.93
	B [69 m]	509970.21	5023450.55
PIT 1	P1	509813.31	5023381.31
PIT 2	P2	509914.31	5023375.42
PIT 3	P3	509825.20	5023476.08
PIT 4	P4	509938.85	5023467.81

Techgea GEOPHYSICS	*VES 1 sounding* ***Tomographic model ERT 1 (A→B) e VES 1 profile***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 2



Vertical electrical sounding (VES 1)



Depth [m]	Rho [log (Ω·m)]	Rho [Ω·m]
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-1	3.17	1481.3
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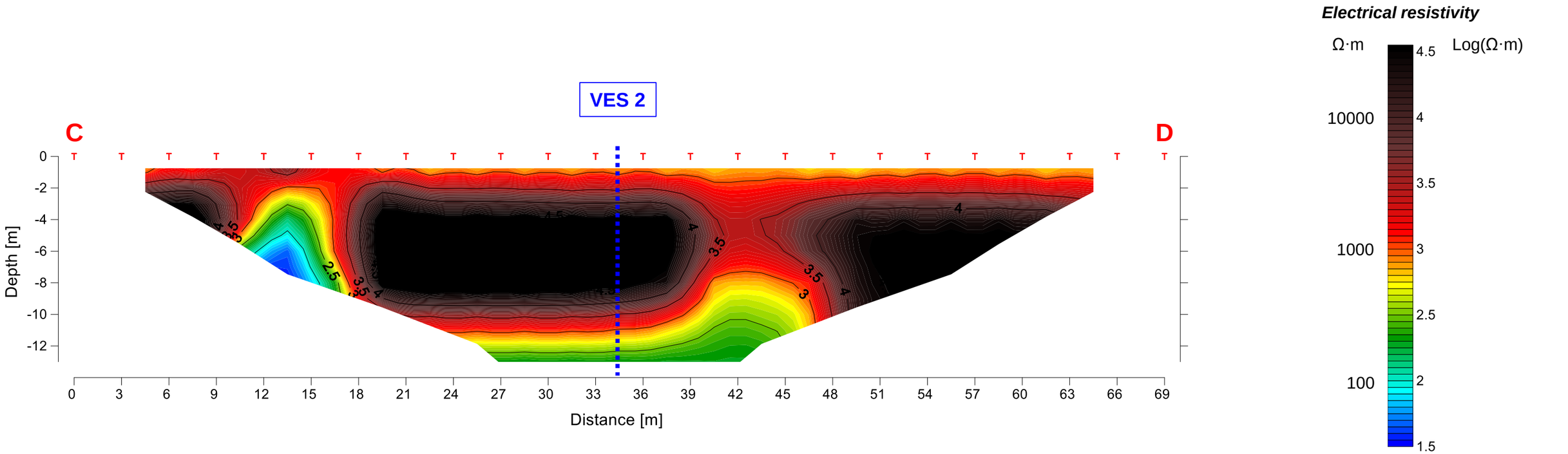
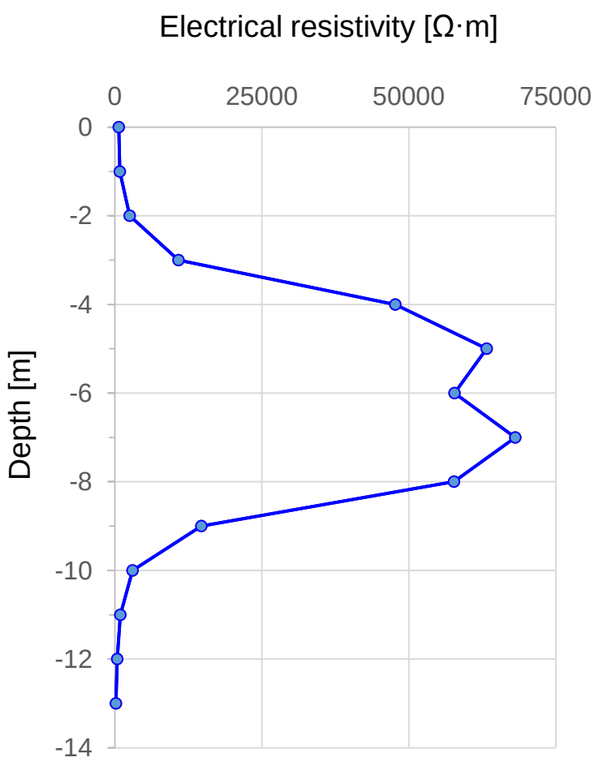
-9	3.90	7913.6
-10	3.59	3885.8
-11	3.41	2561.8
-12	3.33	2140.6
-13	3.28	1904.8

Test ID	East [m]	North [m]
VES 1	509813.31	5023381.31

Techgea GEOPHYSICS	*VES 2 sounding* ***Tomographic model ERT 2 (C→D) e VES 2 profile***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 3

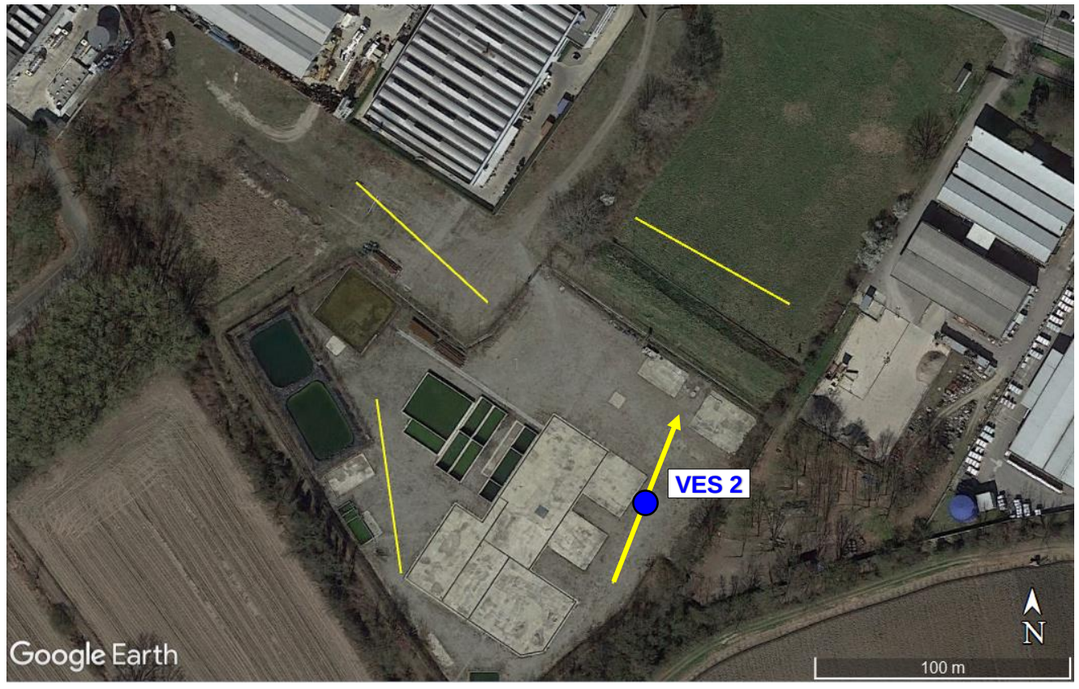


Vertical electrical sounding (VES 2)

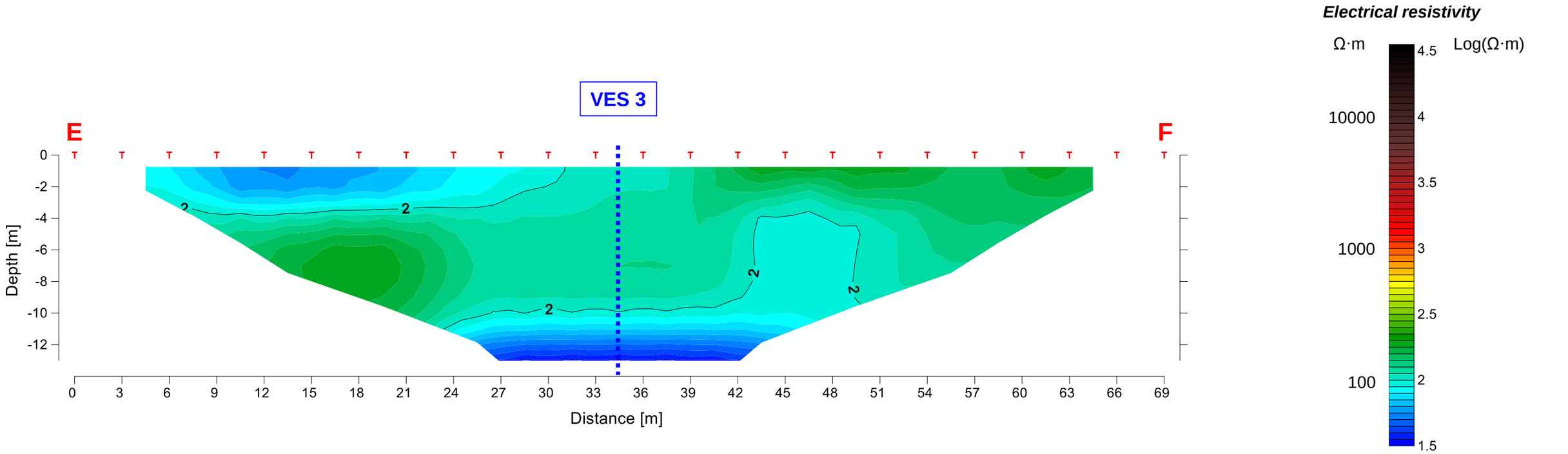


Depth [m]	Rho [log (Ω·m)]	Rho [Ω·m]
0	2.82	667.7
-1	2.93	855.0
-2	3.40	2519.1
-3	4.03	10828.8
-4	4.68	47733.2
-5	4.80	63271.0
-6	4.76	57807.7
-7	4.83	68107.2
-8	4.76	57702.7
-9	4.17	14727.3
-10	3.48	3027.1
-11	2.97	924.8
-12	2.60	394.2
-13	2.29	196.2

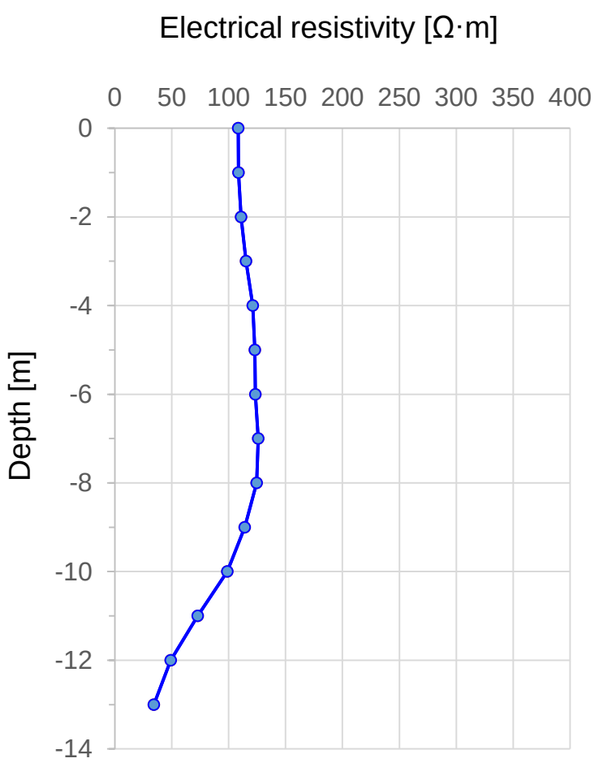
Test ID	East [m]	North [m]
VES 2	509914.31	5023375.42



Techgea GEOPHYSICS	*VES 3 sounding* ***Tomographic model ERT 3 (E→F) e VES 3 profile***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 4

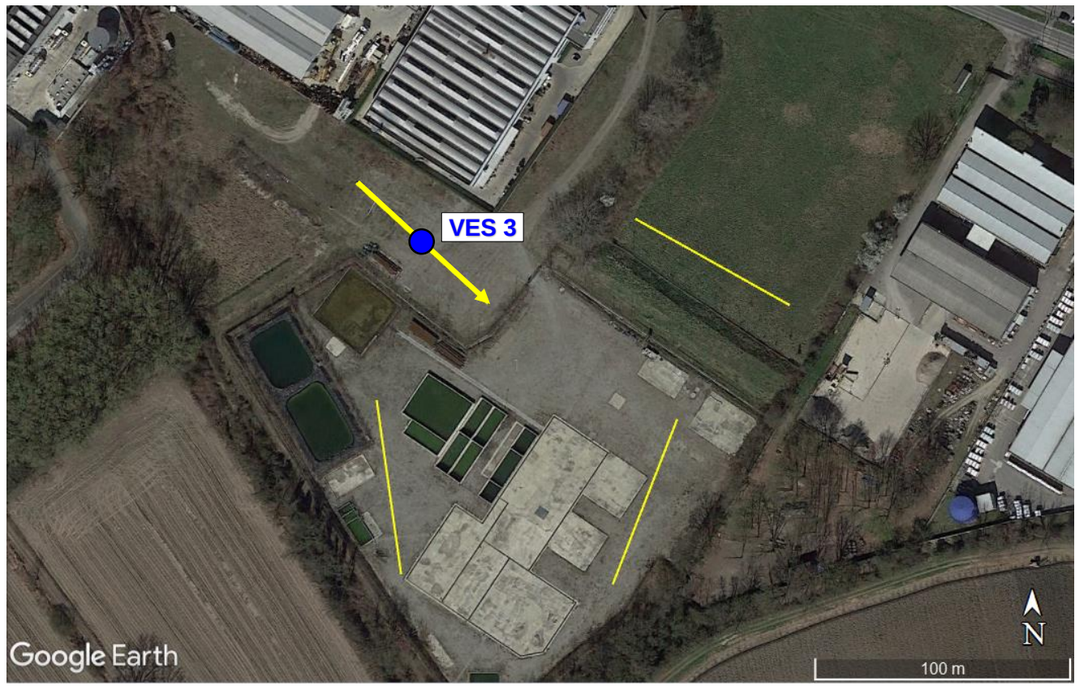


Vertical electrical sounding (VES 3)



Depth [m]	Rho [log (Ω·m)]	Rho [Ω·m]
0	2.04	108.4
-1	2.04	108.7
-2	2.04	110.9
-3	2.06	115.3
-4	2.08	121.3
-5	2.09	123.0
-6	2.09	123.6
-7	2.10	126.0
-8	2.10	124.7
-9	2.06	114.2
-10	2.00	98.9
-11	1.86	72.9
-12	1.69	49.2
-13	1.53	34.2

Test ID	East [m]	North [m]
VES 3	509825.20	5023476.08



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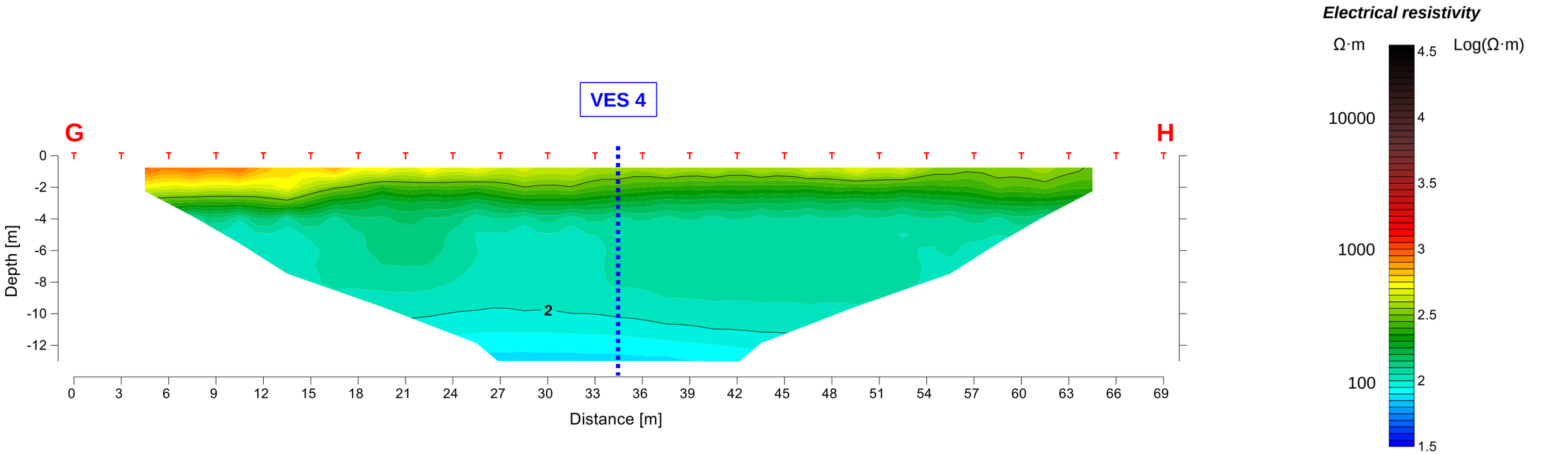
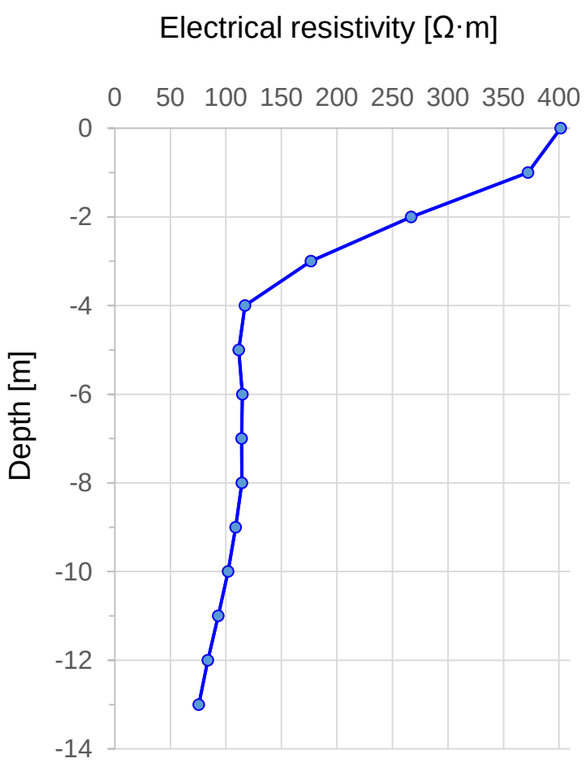
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 5

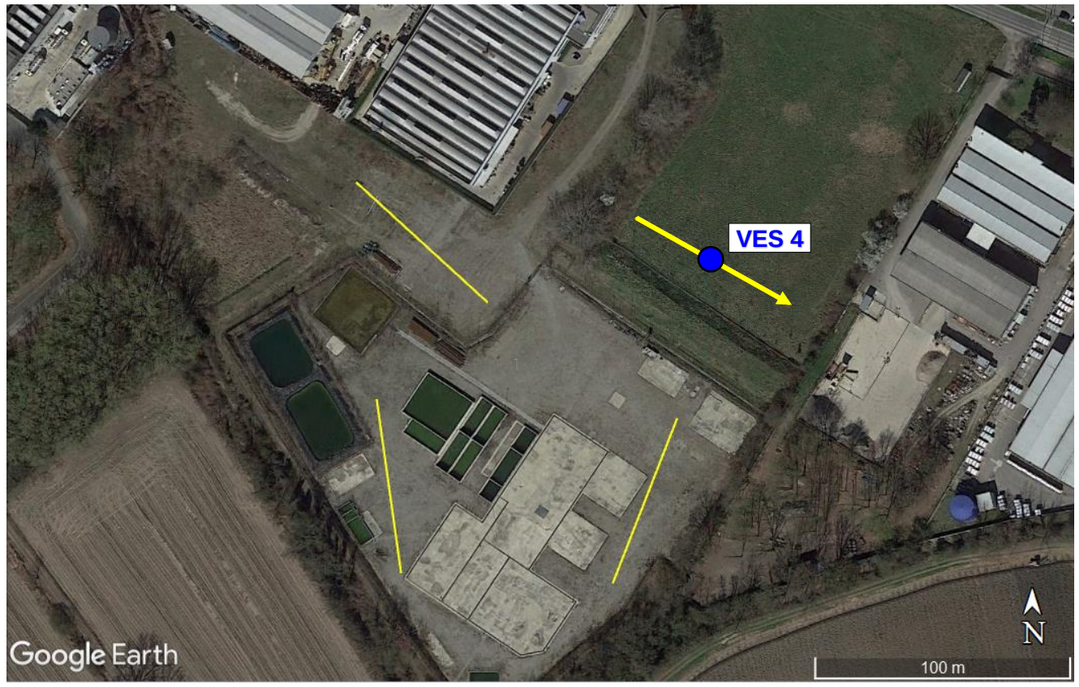


Vertical electrical sounding (VES 4)



Depth [m]	Rho [log (Ω·m)]	Rho [Ω·m]
0	2.60	401.5
-1	2.57	372.2
-2	2.43	266.9
-3	2.25	176.6
-4	2.07	117.2
-5	2.05	111.6
-6	2.06	114.8
-7	2.06	114.1
-8	2.06	114.4
-9	2.04	108.9
-10	2.01	102.1
-11	1.97	93.2
-12	1.92	83.8
-13	1.88	75.6

Test ID	East [m]	North [m]
VES 4	509938.85	5023467.81

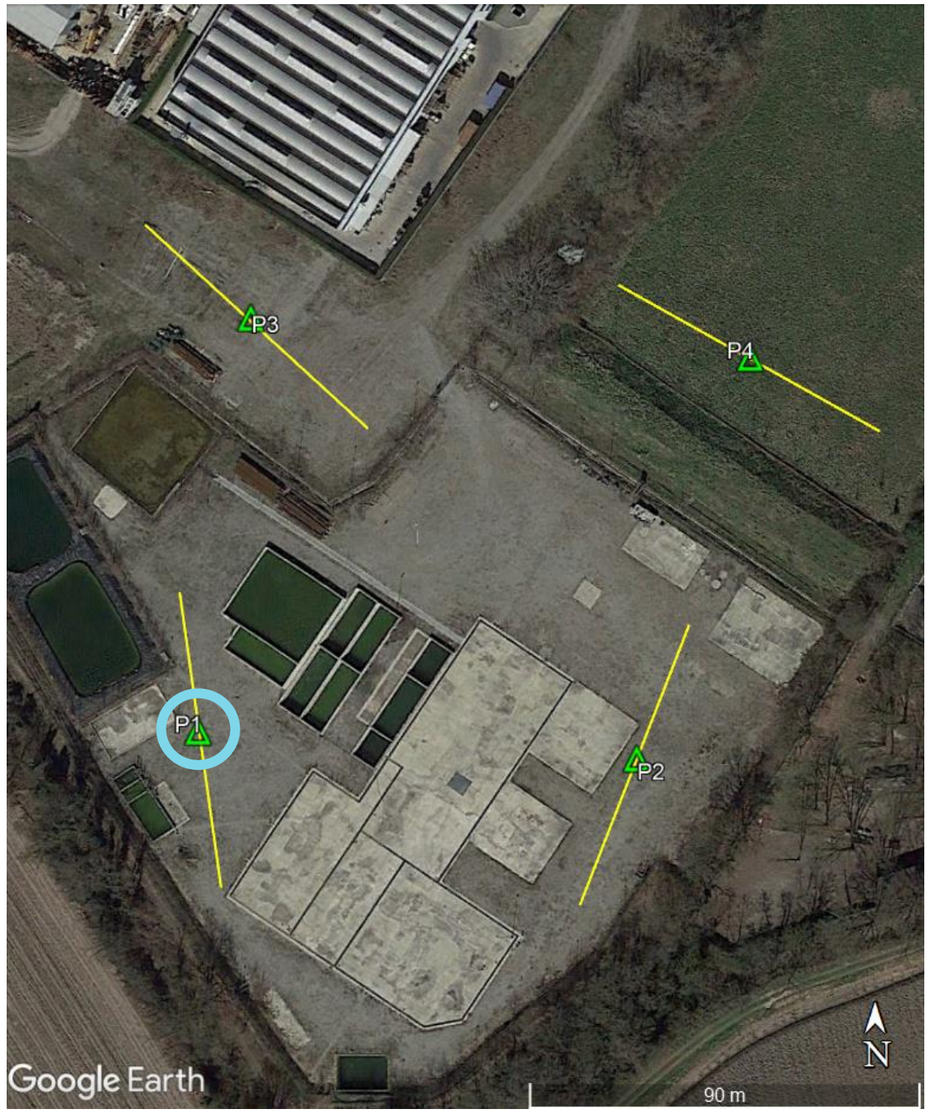


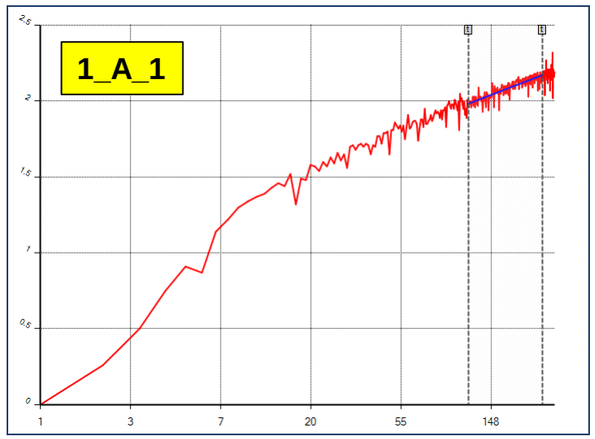
Techgea GEOPHYSICS	*TEST PIT 1* ***Thermal resistivity of the soil***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 6

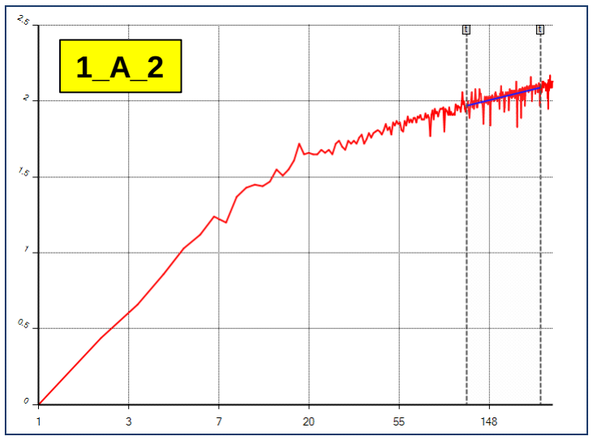
Parameter	Unit	Setting
Resistivity/probe	Ohm/m	83.53
Voltage	V	4
Power	W/m	4.43027
Time	s	300

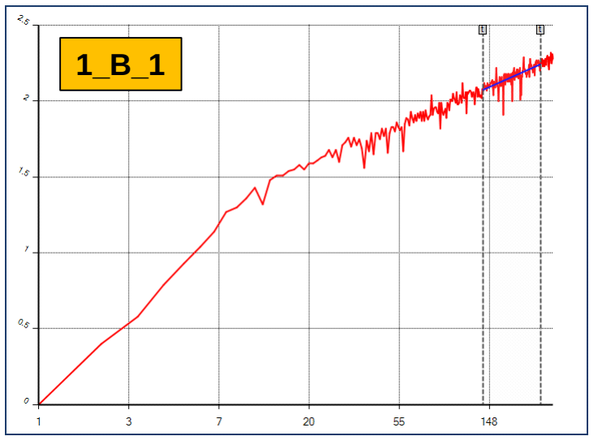
Test PIT 1	Unit	MIN	MAX	AVG
Thermal conductivity	**W/mK**	**1.33**	**2.42**	**1.88**
Thermal resistivity	**mK/W**	**0.41**	**0.75**	**0.57**

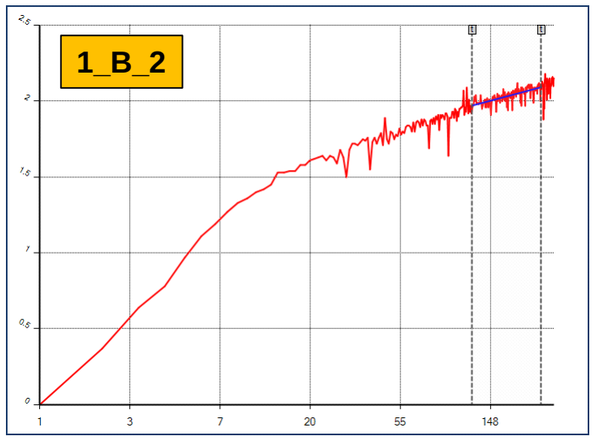
Test PIT 1		1_A_1	1_A_2	1_B_1	1_B_2
Parameter	**Unit**	**Calculated parameters**			
Time t1	s	115	115	138	121
Time t2	s	261	261	261	260
Temperature T1	°C	11.64	11.79	12	12.14
Temperature T2	°C	11.83	11.94	12.18	12.27
Parameter	**Unit**	**Results**			
Thermal conductivity	W/mK	1.539	2.417	1.333	2.235
Thermal resistivity	mK/W	0.65	0.414	0.75	0.447
Start Temperature	°C	9.66	9.83	9.93	10.19
End Temperature	°C	11.85	11.96	12.21	12.34









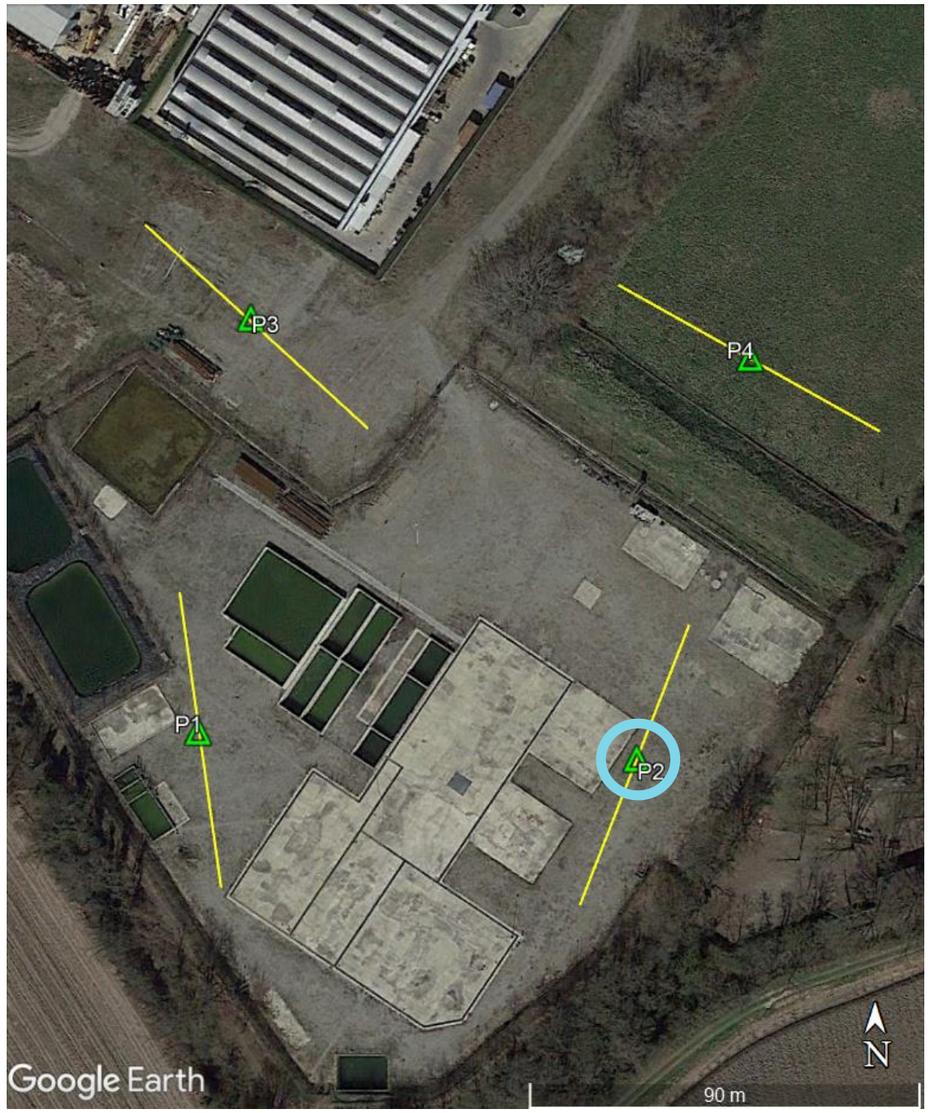


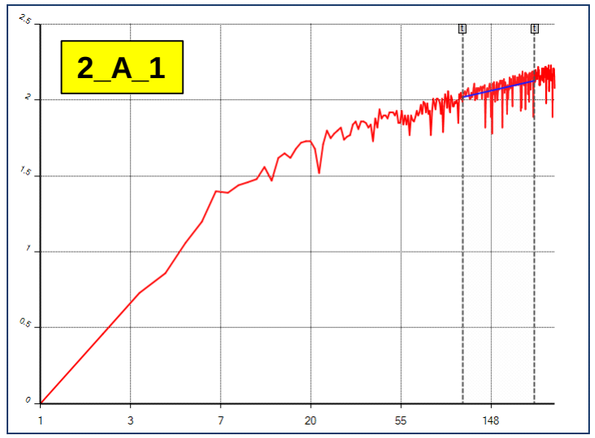
Techgea GEOPHYSICS	*TEST PIT 2* ***Thermal resistivity of the soil***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 7

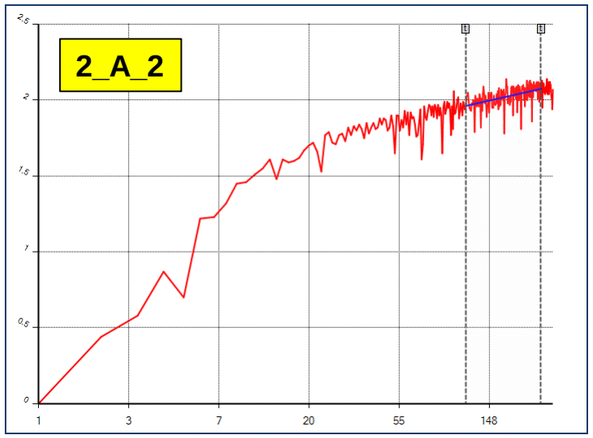
Parameter	Unit	Setting
Resistivity/probe	Ohm/m	83.53
Voltage	V	4
Power	W/m	4.43027
Time	s	300

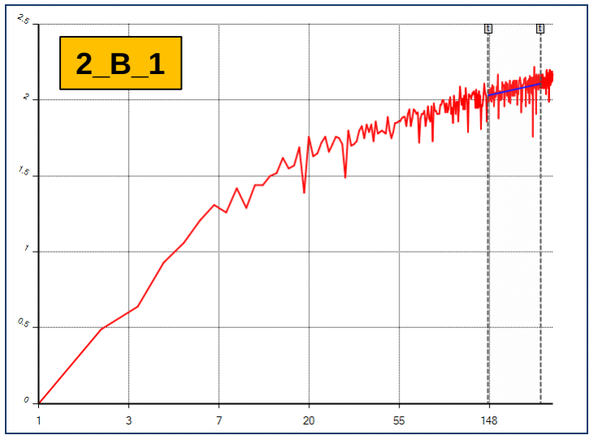
Test PIT 2	Unit	MIN	MAX	AVG
Thermal conductivity	**W/mK**	**2.60**	**3.29**	**2.78**
Thermal resistivity	**mK/W**	**0.30**	**0.39**	**0.36**

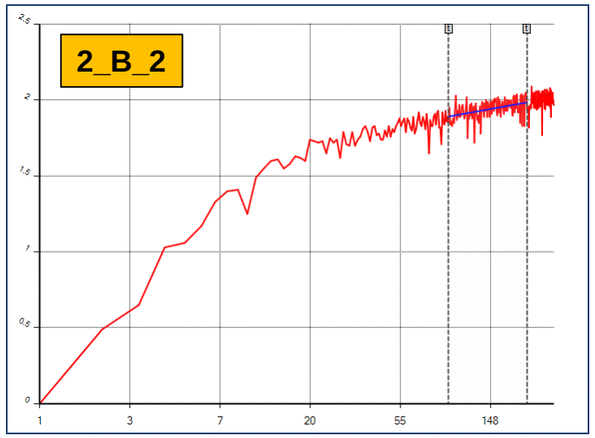
Test PIT 2		2_A_1	2_A_2	2_B_1	2_B_2
Parameter	**Unit**	**Calculated parameters**			
Time t1	s	108	114	146	93
Time t2	s	240	263	261	222
Temperature T1	°C	12.07	12.17	11.97	12.05
Temperature T2	°C	12.22	13.35	12.09	12.17
Parameter	**Unit**	**Results**			
Thermal conductivity	W/mK	2.596	2.611	2.643	3.288
Thermal resistivity	mK/W	0.385	0.383	0.378	0.304
Start Temperature	°C	10.08	10.23	9.98	10.2
End Temperature	°C	12.16	12.3	12.15	12.17









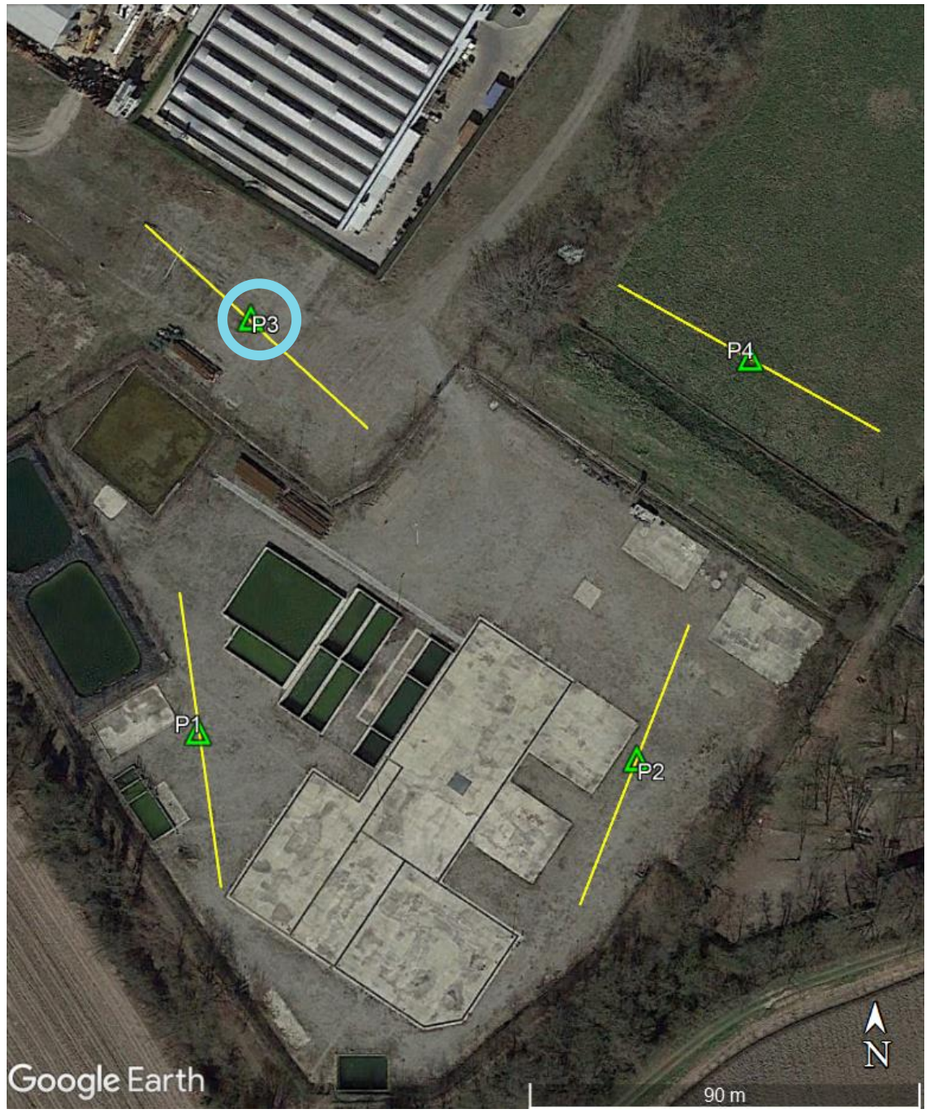


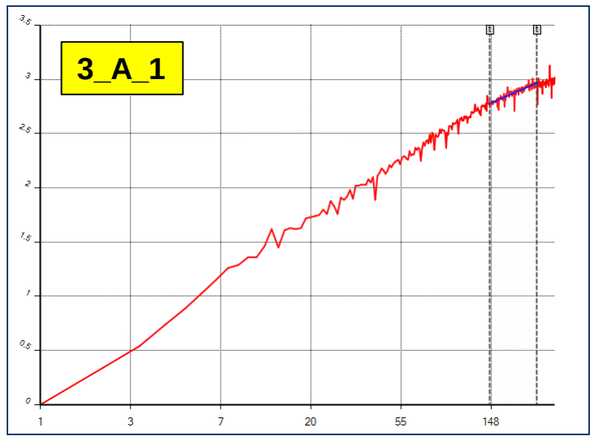
Techgea GEOPHYSICS	*TEST PIT 3* ***Thermal resistivity of the soil***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 8

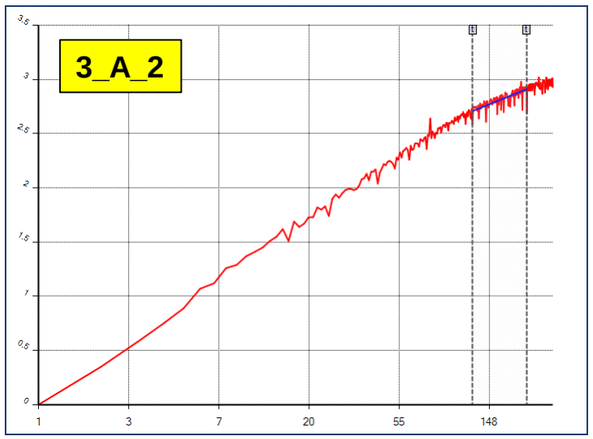
Parameter	Unit	Setting
Resistivity/probe	Ohm/m	83.53
Voltage	V	4
Power	W/m	4.43027
Time	s	300

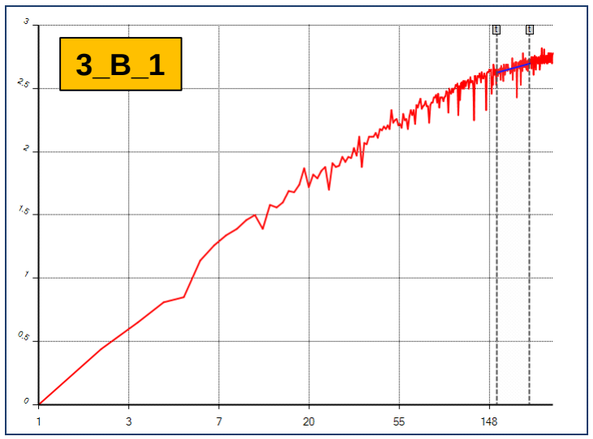
Test PIT 3	Unit	MIN	MAX	AVG
Thermal conductivity	**W/mK**	**0.97**	**1.83**	**1.41**
Thermal resistivity	**mK/W**	**0.55**	**1.04**	**0.77**

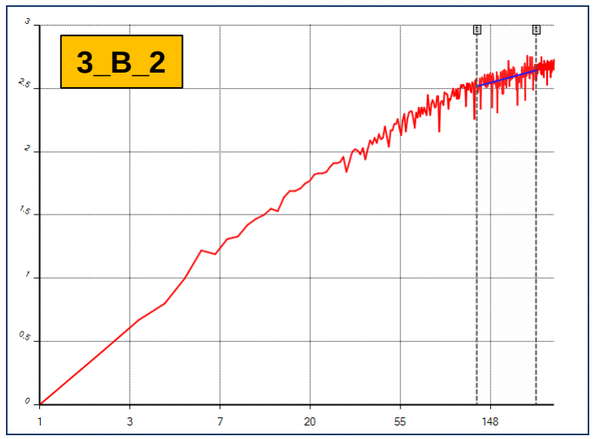
Test PIT 3		3_A_1	3_A_2	3_B_1	3_B_2
Parameter	**Unit**	**Calculated parameters**			
Time t1	s	146	123	161	128
Time t2	s	247	224	232	247
Temperature T1	°C	13.05	12.82	12.75	12.69
Temperature T2	°C	13.23	13.17	12.83	12.77
Parameter	**Unit**	**Results**			
Thermal conductivity	W/mK	0.966	1.049	1.798	1.832
Thermal resistivity	mK/W	1.035	0.953	0.556	0.546
Start Temperature	°C	10.26	10.23	10.1	10.2
End Temperature	°C	13.28	13.16	12.88	12.93









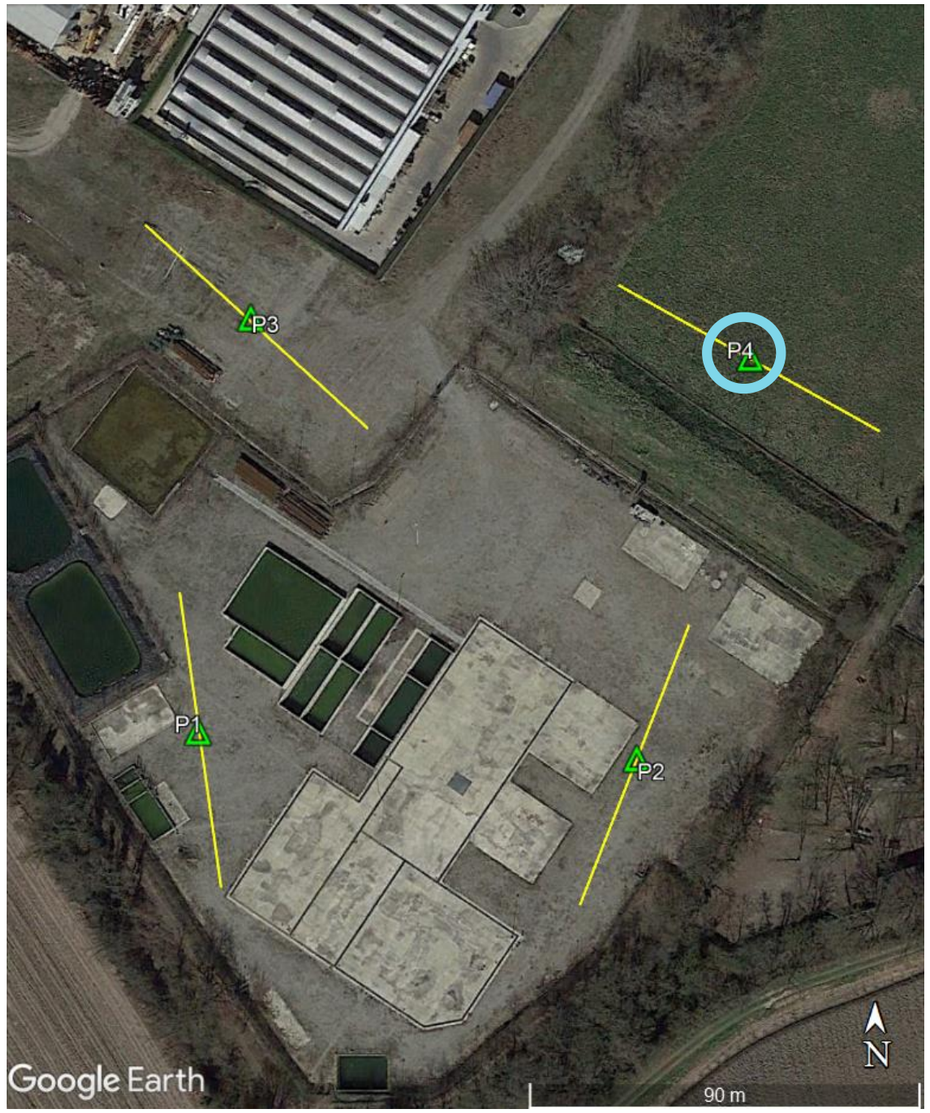


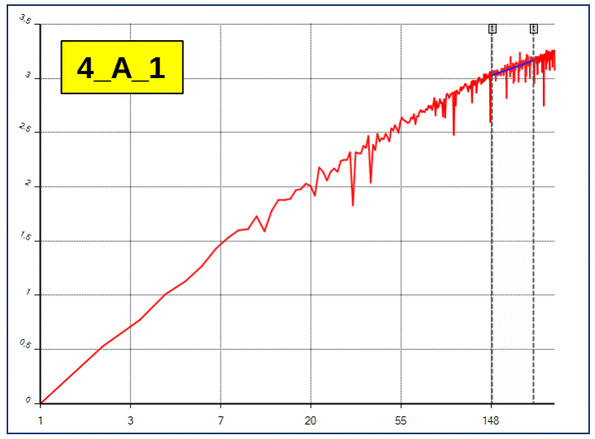
Techgea GEOPHYSICS	*TEST PIT 4* ***Thermal resistivity of the soil***	Client: ARCADIS Italia S.r.l.	Report: 23-421
		Site: Zibido San Giacomo (MI)	Revision: 0
		Date: December 2023	Drawing: 9

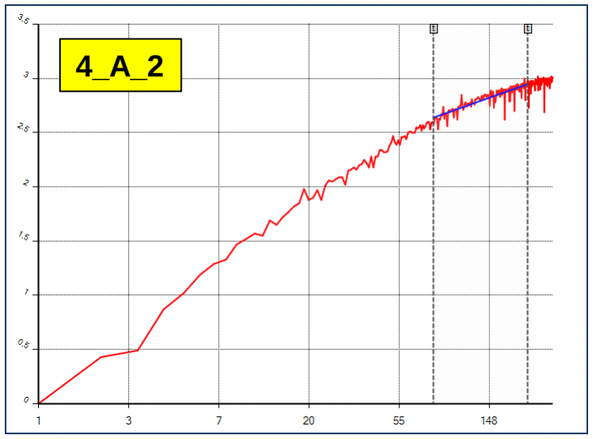
Parameter	Unit	Setting
Resistivity/probe	Ohm/m	83.53
Voltage	V	4
Power	W/m	4.43027
Time	s	300

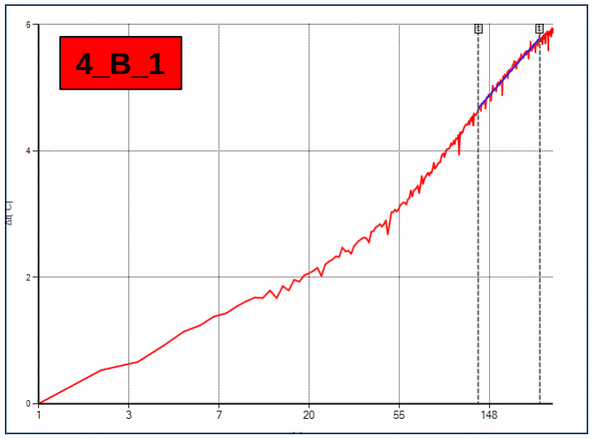
Test PIT 4	Unit	MIN	MAX	AVG
Thermal conductivity	**W/mK**	**1.19**	**1.20**	**1.19**
Thermal resistivity	**mK/W**	**0.84**	**0.84**	**0.84**

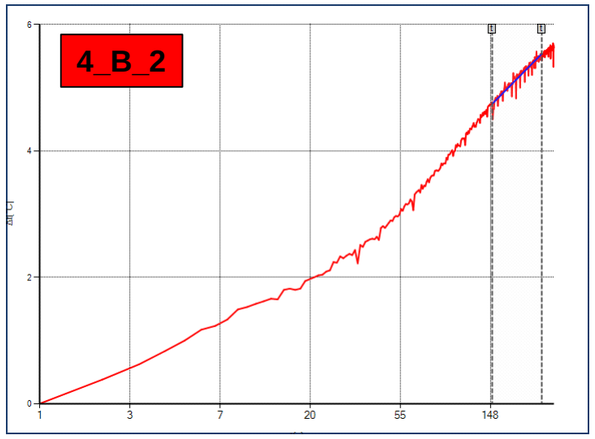
Test PIT 4		4_A_1	4_A_2	4_B_1	4_B_2
Parameter	**Unit**	**Calculated parameters**			
Time t1	s	150	80	131	151
Time t2	s	238	227	259	262
Temperature T1	°C	14.15	13.96	15.64	16.12
Temperature T2	°C	14.26	14.36	16.76	16.78
Parameter	**Unit**	**Results**			
Thermal conductivity	W/mK	1.194	1.195	0.217	0.245
Thermal resistivity	mK/W	0.838	0.837	4.6	4.086
Start Temperature	°C	11.09	11.38	10.99	11.35
End Temperature	°C	14.17	14.39	16.92	16.98











Appendix A

Measurement of electrical resistivity on an average soil sample (laboratory test)

ALTAIR S.R.L.

Laboratorio Autorizzato dal Ministero delle Infrastrutture e dei Trasporti prove terre (settore "a") e rocce (settore "b")
D.P.R. 06.06.2004 n.380 - Circ. 7618/STC del 08.09.2010 Autorizzazione n. 52505 del 11.10.2004 e successivi rinnovi
Laboratorio Certificato UNI EN ISO 9001:2008 ICMQ n.11353 del 28.10.2011

Certificate n. 141	**of 15/01/2024**	**Accettamps r 3564**	**of 29/12/2023**

ELECTRICAL RESISTIVITY

CLIENT:	PRESTON ZIBIDO SAN GIACOMO
PROJECT NUMBER:	-
PROJECT NAME:	ZIBIDO SAN GIACOMO (MI)
BORING :	-
SAMPLE:	C1 IN CLASSE Q3
DEPTH :	-

Start test date	-	14/01/2024
End test date	-	15/01/2024

EXPERIMENTAL DATA

Remolded Sample		*Ω*m*	**69,44**

Capitale Sociale € 95.000,00.- i.v. Sede Legale Via E. Pagliano, 37 20149 MILANO
Laboratorio: Via A. Martini, 11 20092 CINISELLO BALSAMO (MI) Tel. 0261293850 r.a. Fax 0261770281
E-mail:info@geoaltair.it P.E.C.:altairsrl1@legalmail.it R.E.A. n. 1198777 – Registro Imprese Milano / C.F. / p.IVA n. 08041580153

LABORATORY MANAGER:

Appendix B
Technical specifications

IRIS INSTRUMENTS

RESISTIVITY SOUNDING AND IMAGING SYSTEM

SYSCAL Pro

resistivity & IP equipment

for SOUNDING, IMAGING and MONITORING

SYSCAL Pro Switch MAIN FEATURES

- **The SYSCAL Pro Switch** is a versatile electrical resistivitymeter which combines a transmitter, a receiver and a switching unit in one single casing. It is supplied by a 12V battery.
- **The measurements** are carried out automatically (output voltage, stacking number, quality factor) after selection of limit values by the operator, and are stored in the internal memory.
- **The output specifications** are 800V (1 600V peak-to-peak) in switch mode, 1 000V (2 000V peak-to-peak) in manual mode, 2.5A, and 250W with the internal converter and a 12V battery.
- **The SYSCAL Pro Switch** uses multi-core cables for controlling a set of electrodes connected in a line or in several lines. The standard number of electrodes: 24, 48, 72, 96, 120, can be increased through Switch Pro units for 2D or 3D ground images.
- **The ten channels** of the system permit to carry out up to 10 readings at the same time for a high efficiency.
- **The Induced Polarisation chargeability (IP)** is also measured through 20 windows for a detailed analysis of the decaying curves displayed on the graphic LCD screen.
- **The SYSCAL Pro Switch unit** can be operated with cables in boreholes, or cables pulled on the ground by a vehicle or on the surface of the water by a boat for continuous acquisition surveys.
- **The SYSCAL** can be used for time lapse readings (monitoring)

1D, 2D, 3D, 4D
RESISTIVITY INVESTIGATIONS

for characterizing underground structures:

- ENVIRONMENT
- CIVIL ENGINEERING
- GROUNDWATER
- ARCHAEOLOGY
- MINING EXPLORATION

TEN SIMULTANEOUS CHANNELS:
for high speed data acquisition, up to 1 000 rdgs/mn

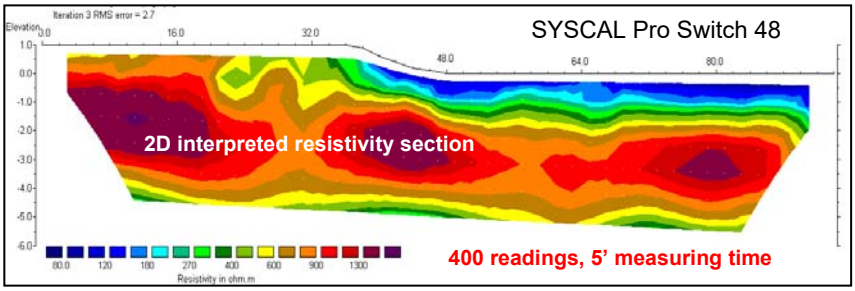
UP TO 800 - 1 000V, 2.5A OUTPUTS:
for penetration & data quality

AUTOMATIC SWITCHING CAPABILITY:
for 24, 48, 72, 96, 120, up to 1 300 electrodes

RESISTIVITY & INDUCED POLARIZATION:
twenty IP chargeability windows

PC SOFTWARE:

- **ELECTRE Pro:** sequence management
- **PROSYS II:** data transfer, process, display
- **COMSYSPro:** control of SYSCAL by PC
- **SYSMAR:** continuous acquisition
- **PROCESSING:** x2ipi (w/seq manag.)
- **INTERPRETE:** ERTLab (w/seq manag.) Res2/3Dinv, IX1D, Winsev



SYSCAL Pro SPECIFICATIONS

TRANSMITTER
- Max voltage: 800V in switch mode
- Max voltage: 1 000V in manual mode
- Max current: 2.5A, typ. accuracy 0.2%
- Max power : 250W with internal DC/DC converter and 12V external battery; 1200W with external AC/DC and Motor Gene.
- Option 25mA max for readings on samples
- Pulse duration: 0.2s, 0.5s, 1s, 2s, 4s, 8s
- Internal 12V, 7Ah battery, plug for ext. batt.

RECEIVER
- Automatic ranging, 10 true differential input channels
- Input impedance: 100 Mohm
- Max input voltage : 15V
- Protection up to 1 000V
- Typ accuracy: 0.2%, resolution: 1 microV
- Digital rejection better than 120 db at power lines 50 and 60 Hz
- Stacking process, SP linear drift correction
- Reading of current, voltage, standard dev., 20 IP windows (preset or selectable),

GENERAL
- Memory: 44 800 readings USB & SD card link (7 000000 readings in option)
- GPS input for coordinates
- Fiber glass casing, weather proof
- Temperature range: -20 to +70°C
- Syscal Pro Sw48:31x23x36cm
- Weight: 13kg, Cable w/ 24 take-out: 23kg

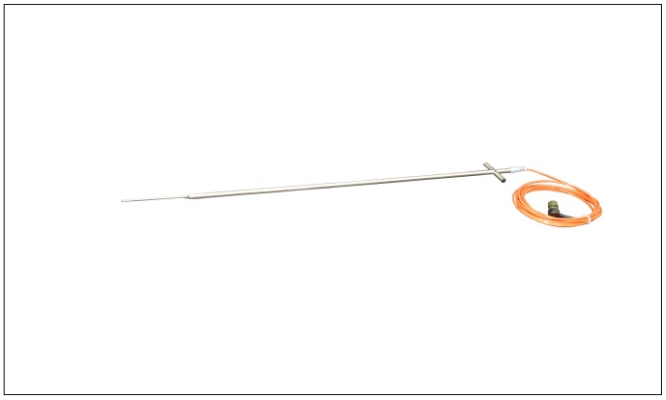
CTS120

THERMAL CONDUCTIVITY PROBE FOR SOIL

CTS120 is a probe, for measures in the soil (lenght = 120 cm), that offers the possibility to perform a practical and fast measurement of the thermal conductivity (or thermal resistivity) of the medium in which it is inserted at a high accuracy level. It works in compliance with the ASTM D 5334-00, D 5930-97 and IEEE 442-1981 standards. The probe has proven its suitability for soils, thermal backfill materials, sediments, foodstuff, powders, sludges, paints, glues and various other materials. The Non-Steady-State Probe (NSSP) measurement method (also known as transient line source, thermal needle, hot needle, heat pulse- and hot wire technique) has the fundamental advantages that it is fast and absolute while the sample size is not critical. Hukseflux is specialised in NSSP design. Special models have been developed for in-situ field experiments.

CALIBRATION - ISO 9000

Verification of the stability of the total probe can be done by repeated (yearly) testing in glycerol, preferably at several temperatures. Alternatively Calibration Reference Cylinders (CRC) traceable to NPL is available optionally. CTS120 is suitable for use by ISO certified labs.



Physical		
Size (Lip Diameter x Height)	mm	16x1200
Weight	g	1200
Sensing Element	TP09	
Housing Material	Stainless Steel	
Sealing	Welded Hermetic	
Electrical Connector and cable	Amphenol 10 poles with 5 meters of cable	

Calibration result	
Eletrical resistance/meter	Re=84.98Ω/m
Calibration uncertainty	*±0.85Ω/m

*the number following the± symbol is the expanded uncertainty with a coverage factor k=2, and defines an interval estimated to have a level of confidence of 95%

Measurement process	
Metrological characteristic	Re in (Ω/m): sensitivity to electrical resistance
Calibration method	Hukseflux TNC
Uncertainty of the method	the expanded uncertainty is ±1%

Metrological traceability	
Calibration traceability	traceability of calibration is to th SI units of m and the derived SI unit of Ω
Calibration hierarchy	from SI through international standards

Evaluation of the uncertainty of the calibration result	
Uncertainty calculation	based on nominal values and rectangular distribution, K=2 (GUM)